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ANALYSIS OF THE POTENTIAL FOR THE INTEGRATION OF AN EV FLEET INTO THE POWER GRID

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OVERVIEW

In the near future two main issues, concerning the electric mobility, will emerge. At first the alternatives of integrating a large fleet of electric vehicles (EV) into the grid shall be analyzed and evaluated. In this context, the consideration of renewables is one of the main topics. The second issue is the behavior analysis of the batteries in respect to the different integration and charging methods.

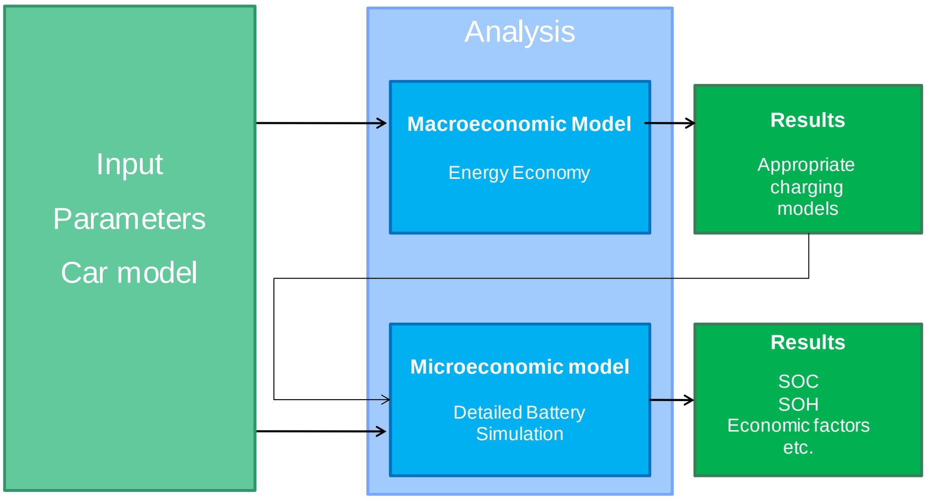

Fig. 1. Methodology

The answer to these questions shall be derived by combining the macro- and the micro-economic view of the battery/car respectively owner/operator. The energy-economic view is conducted by the interaction between the EV fleet and the different power supply markets.
The main topics of the micro-economic view are the energy prices and the aging of the battery resulting from different charging methods in the various markets.
It is assumed that by 2020 about one million EVs will be used in Germany. There are different markets for the power supply in Germany that can be used in different strategies for charging the batteries of fleets. The value of the grid services by the EVs accumulates with the complexity of the market.

METHODS

A simulation and analysis of the different charging strategies of a given fleet of EVs and PHEVs has been performed (macroeconomic model). The results enable the identification of the interaction between various cars and markets for electrical power. The markets are: domestical power supply (any-time charging and night-only charging), Day-Ahead, Intra-Day and the load frequency control markets (primary, secondary and tertiary control).
The best performing charging strategies (appropriate charging models) are analyzed more in depth in the microeconomic model. Beside the cost calculation for the electricity, the main

question is how the chosen charging strategy will affect the aging (State of Health) of the battery compared to a reference charging strategy. The validation of the battery simulation relies on a complex measurement project currently running at the FfE (e.g. /1/).
For the evaluation of the energy demand of the cars, a special model was conceived and validated by a series of measurements in an HEV (Toyota Prius II) (e.g. /1/). The energy consumption of the fleet correlates with the results of statistical data which were gained by the FfE during a former project (/2/).

RESULTS

Initial results show a strong dependency between the vehicles usage and the possible energy markets available for charging. The state of charge (SOC) of the batteries is directly affected by the charging model. Fig. 2 shows the frequency distribution of the SOC at the end of every ride over one year using two different charging methods (left: direct charging; right: secondary control power). In the first picture the SOC does not drop below 60 %. Using power control (right picture) means that the batteries of the cars use the complete range of SOC. In this case, the hazard of a discharged battery is larger.

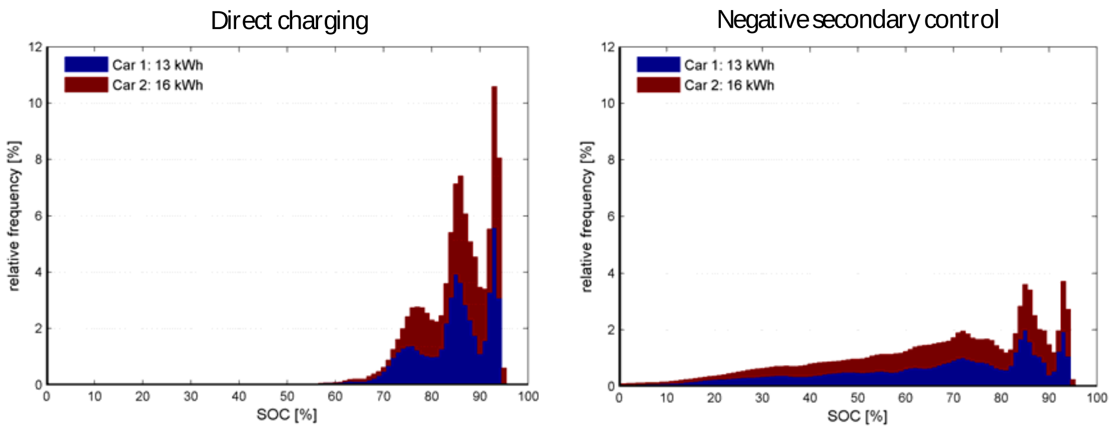

Fig. 2. Results

CONCLUSIONS

First results show that there is a need for intelligent charging methods in scenarios with a high penetration level of EVs. The potential of supplying grid services (load frequency control) and integration of renewable energy sources (balancing) increases with the size of the fleet, as well as the complexity for managing the charging of the vehicles.

REFERENCES

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